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Blueberry Growing

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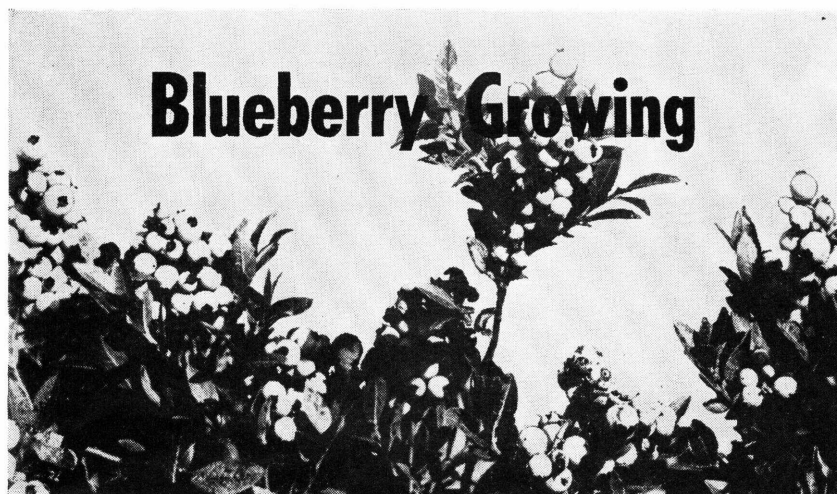
U. S. DEPARTMENT OF AGRICULTURE

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Washington, D. C.

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DEVELOPMENT OF THE BLUEBERRY INDUSTRY ¹

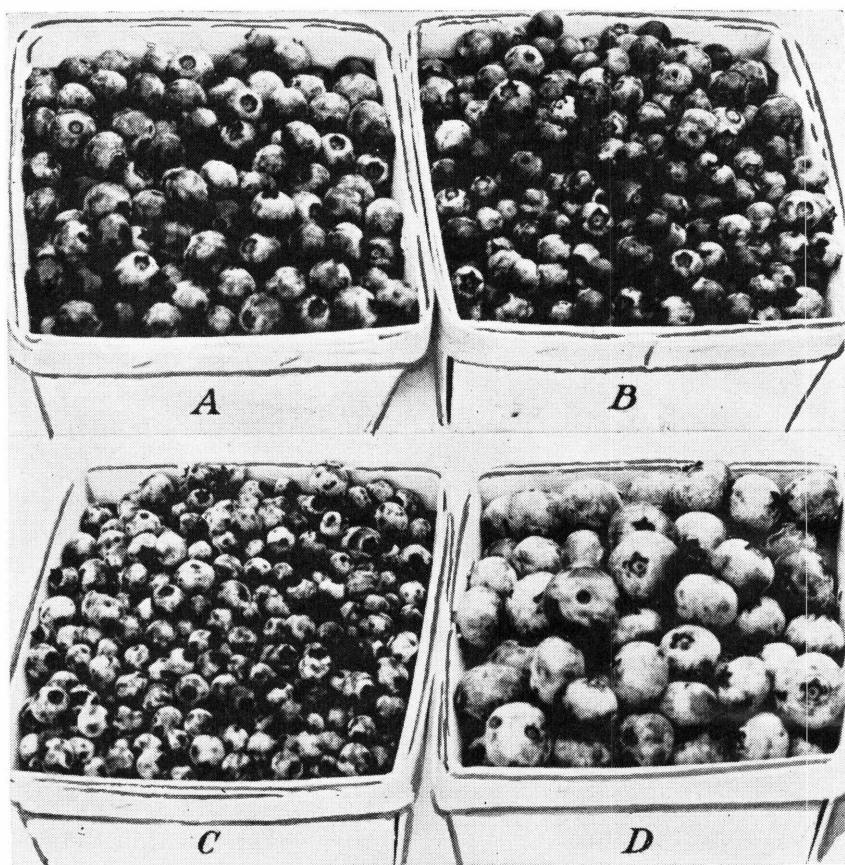
Blueberries, originally native North American wild fruits, are becoming an increasingly important cultivated crop in parts of the United States. They can be marketed fresh, canned, or frozen.

Prior to 1910 there were at least two cultivated plantings of high-bush blueberries made with bushes selected from the wild. Subsequently the breeding and selection work of the late F. V. Coville laid the foundation for a new blueberry industry. The extent of the improvement made in the blueberry by Coville is indicated in figure 1, which shows the comparative size of the fruit of one of his largest fruited seedlings (fig. 1, *D*) and of Rubel, the best selection from the wild (fig. 1, *A*).

The first commercial shipments of cultivated blueberries were made in 1916. In 1955 there were about 6,000 acres under cultivation in New Jersey, over 1,000 acres in North Carolina, about 4,500 in Michigan, and possibly 1,000 acres in other States, chiefly in Washington, Oregon, Massachusetts, and New York. For 1955 the value of the crop from cultivated fields in New Jersey was about \$5 million; in North Carolina \$1 million; and in Michigan \$4 million.

The first commercial planting of the rabbiteye blueberry, a wild blueberry of the South, was made by M. A. Sapp in western Florida about 1893 with bushes transplanted from the wild. Between 1920 and 1930 some 2,225 acres in Florida were set with plants transplanted from the wild or propagated from the early plantings and selections. Similar plantings were also made in Louisiana, Mississippi, Alabama, Georgia, South Carolina, and North Carolina. Few of these plantings were made with selected bushes, and since 1930 relatively few of them have been cultivated. The crop of the rabbiteye blueberry is nearly

¹ The name "blueberry," as used in this bulletin designates the group of plants, commonly called "blueberries" and "huckleberries," that have many very small, soft seeds in contrast to the true huckleberries, which have 10 large, bony seeds.



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FIGURE 1.—Berries from different sources: *A*, Rubel the best highbush selection from the wild; *B*, wild highbush blueberry of eastern United States; *C*, wild lowbush blueberry of the Northern States; *D*, cross of two highbush varieties. Note the large size of the berries from the cross.

all from such plantings, and very little of it comes from the wild bushes.

Although the blueberry crop from all cultivated varieties had a value of more than \$11 million in 1955, the total value of the industry in the United States is much greater, as wild blueberries are harvested in several widely separated areas: The blueberry barrens and uplands of New England, New York, Pennsylvania, West Virginia, Michigan, Wisconsin, and Minnesota; the swamplands along the Atlantic coast and in the Northeastern States; the upland sections of Alabama, Georgia, and other Southern States; the Cascade Mountains section of Oregon and Washington; the coastal section of northern California, Oregon, and Washington. Figure 2 shows the location of the areas in the United States from which native berries are most extensively harvested and marketed.

In the case of various other fruits, selection and breeding of superior varieties have enabled the grower to place on the market a product so much superior to that from the wild that relatively small quantities of such wild types are now marketed fresh. With the blueberry,

superior varieties of the highbush and of the rabbiteye are now being grown. The largest fruited varieties are being hybridized with drought-resistant species in order to obtain very large-fruited drought-resistant varieties that might also be used in erosion control. If produced at a sufficiently low cost, cultivated blueberries may replace much of the crop from the wild, now worth several million dollars annually. They can be grown in home gardens also, provided the soil is sufficiently acid. For home gardens in most areas it is necessary to prevent birds from eating the fruit.

IMPORTANT SPECIES

Fruit from eight species of blueberries is harvested extensively in different parts of the United States and fruit from three others to a more limited extent. They are known as the lowbush (*Vaccinium lamareckii* Camp, formerly *V. angustifolium* Ait.), highbush (*V. australe* Small and *V. corymbosum* L.), dryland (*V. pallidum* Ait. and *V. alto-montanum* Ashe), evergreen (*V. ovatum* Pursh), mountain (*V. membranaceum* Dougl.), and rabbiteye (*V. ashei* Reade). In addition, commercial quantities of the Canada blueberry (*V. myrtilloides* Michx.) are harvested in Maine, usually where it occurs with the lowbush blueberry, and in the Adirondack Mountains of New York, where it is the chief kind at the higher elevations. In the mountains of western North Carolina at least two highbush suckering blueberries (*V. alto-montanum* Ashe, its hybrids, and *V. constablaei* Gray), related to the dryland one, are also harvested commercially.

LOWBUSH BLUEBERRY

The lowbush blueberry, the most important commercial wild species, is native to Northeastern United States and parts of Canada (fig. 2).

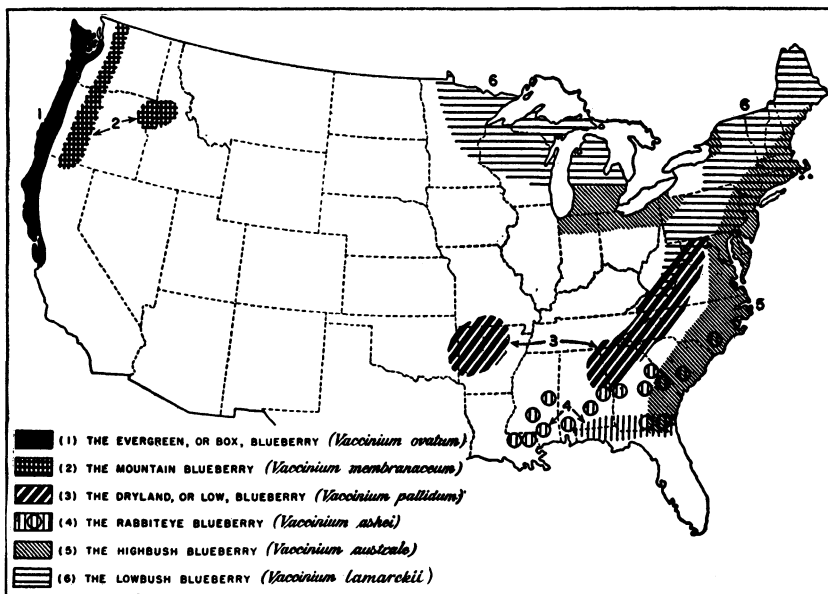


FIGURE 2.—Map of the United States, showing areas in which wild blueberries are extensively harvested.

In the United States, fruit from this species is gathered in commercial quantities from Maine to Minnesota and southward in the Alleghenies to West Virginia. It is an upland species, usually 6 to 18 inches high, which stools into large colonies by means of underground shoots. No named varieties have been propagated for commercial planting. Selections have been made for breeding, for this species crosses readily with the highbush blueberry. Its fruit, which is usually light blue, ripens earlier than that of the highbush blueberry, but the flavor is similar. Although the fruit ripens during July and August, harvesting may extend into September in the most northern areas. The fruit is gathered for the canneries with rakes (fig. 3) similar to the cranberry scoop, but much smaller. For the fresh-fruit market the fruit is picked by hand as well as harvested with rakes. Even though only a part of the total wild crop is harvested, the annual value of the harvested fruit is probably more than \$5 million, the larger part being used by canneries and freezing plants. The Maine crop alone was valued at about \$2 million in 1955.

After the forest has been cut or burned over, the lowbush blueberry comes in naturally in large areas in some of the Northern States. If burning is prevented, sooner or later the area grows up to brush and woodland again. Thus, areas that yield large quantities of berries for a few years may produce none later, owing to the crowding and shading-out of the bushes. In eastern Maine and in some smaller areas elsewhere, however, the fields are reburned every second or third year in the spring while the ground is still wet, to kill back weeds and underbrush (chiefly sweetfern, hardwood sprouts, lambkill or sheep laurel, alder, and hardhack) and to prune the blueberry plants. Either hay or straw with oil is used to help the burning.

As a further aid in control, weeds and bushes may be cut or pulled in the fall previous to burning or killed by brush-killing chemical sprays. Burning-over does not seriously injure the blueberry plants if properly done during the dormant season, but repeated burning lowers soil fertility. The Maine Agricultural Experiment Station reported that mowing sweetfern in July gave about 80 percent control of that weed and that 99 percent of the alder was eliminated by re-



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FIGURE 3.—Harvesting lowbush blueberries for the canneries in eastern Maine. The rake is 10 to 12 inches wide and has 18 to 40 teeth.



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FIGURE 4.—Part of the blueberry barrens, which cover more than 100,000 acres in Washington County, Maine. Most of the blueberries are the lowbush.

moval of the crowns. Dusting with an insecticide for control of the blueberry fruitfly is extensively practiced, and two applications have been found to be very successful. Picking as early as possible, before the berries are infested by the fruitfly, is recommended. In Maine picking for the fresh-fruit market begins about July 20 and for the canneries about August 10. About 150,000 acres of native blueberries in Maine are given some care (fig. 4).

HIGHBUSH BLUEBERRY

The highbush blueberry is native from northern Florida to southern Maine and west to southern Michigan. It is gathered from the wild most extensively in eastern North Carolina and northward along the Atlantic coast to Massachusetts, but in varying quantities throughout its range. The annual value of the crop from wild plants is probably between \$500,000 and \$1,000,000.

The highbush blueberry is a native of swamps, of moist woods, and also of moist, open fields at high elevations. It grows to 10 or 15 feet in height and does not stand drought well. From this species have been selected the plants bearing fruit of large size, such as Rubel, Adams, Harding, Brooks, Sooy, Chatsworth, and Sam. Some of these selections when hybridized have produced the still larger fruited named varieties that are extensively propagated.

DRYLAND BLUEBERRY

The dryland blueberry, also commonly called "low huckleberry," is native from Georgia and Alabama to Maine and westward to Michigan and Oklahoma, but it is important chiefly in northern Alabama and Georgia and northward to Maryland and West Virginia. The plants grow in the dry, relatively poor soils of the ridges and hills and are very drought-resistant. The fruit is gathered most extensively in northeastern Alabama, northwestern Georgia, West Virginia, and western and northwestern Arkansas. The dryland blueberry grows from 1 to 3 feet in height and spreads in colonies much as does the

lowbush blueberry. The berries have a light-blue color, and their flavor is good. They have a small, rather dry scar where the stem was attached. The dryland blueberry commonly ripens later than either the lowbush or the highbush blueberry and is sometimes called the late blueberry. In Georgia and Alabama, however, it ripens before the crop from cultivated fields in New Jersey; therefore, it brings good prices in markets. The annual value of the harvested crop, all from wild plants, may average \$300,000; in some years it is much more. The usual low form of this blueberry does not hybridize with the highbush. However, vigorous taller plants of this general type that bear larger berries than the usual low form and do cross with the highbush varieties have been found in Georgia and Alabama. Recent evidence indicates that this large-fruited dryland blueberry may be the more important commercially in those States.

EVERGREEN BLUEBERRY

The evergreen blueberry, commonly known as evergreen, or coast, "huckleberry," is native along the Pacific coast from central California to British Columbia. The fruit is gathered extensively in northern California, along the coast of Oregon and Washington, and in the

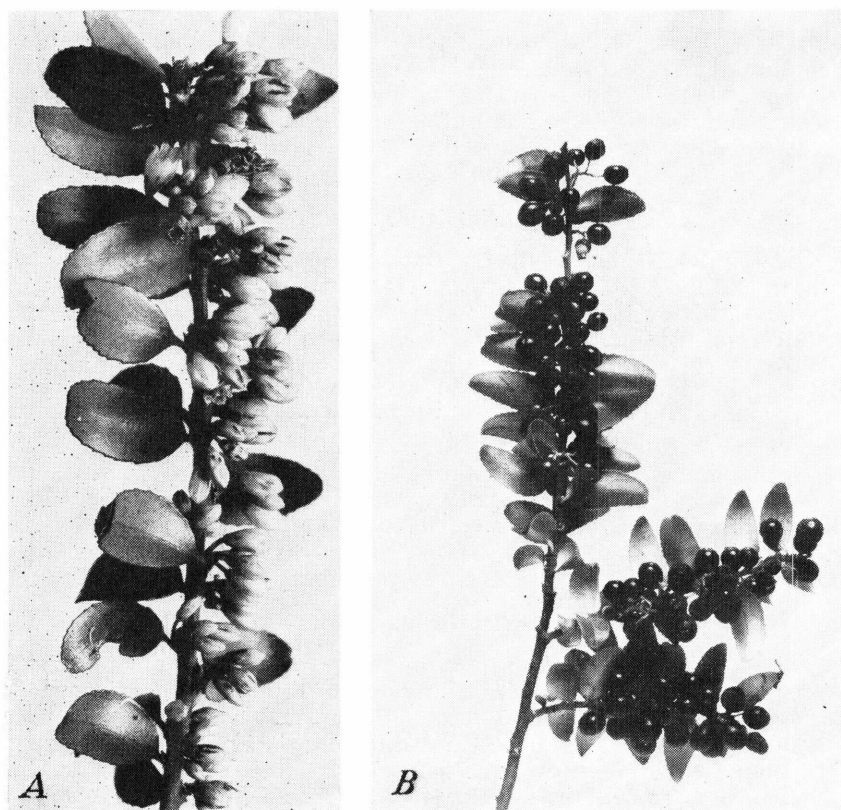


FIGURE 5.—Shoots of the evergreen blueberry: *A*, Showing flower buds and flowers at most nodes, and *B*, fruiting clusters.

Puget Sound district. Branches of this blueberry are important commercially for decorative purposes. They are shipped chiefly from December to March by the carload to eastern cities under the trade name "evergreen huckleberry." The branches for shipment are gathered in open woodland where there is partial shade. The plant is also an attractive ornamental shrub in flower and fruit as well as in leaf (fig. 5). It may reach a height of 20 feet in open woods. No commercial plantings for fruit production are known. The annual value of the fruit crop may be \$150,000 to \$200,000 and that of flowering branches much more.

The berries ripen from August to November, but the chief shipments are made in September and October. The berries are usually small and shiny black and have a characteristic strong flavor not at all like that of other blueberries. This flavor makes them less desirable than other blueberries for eating fresh. They are extensively used, however, for pies and otherwise in cooking. A variation with slightly bluish fruit is not uncommon. A large part of the crop is stored frozen for use by pie makers.

The evergreen blueberry grows only in the mild climate near the Pacific coast and around Puget Sound; it has not been hardy in eastern United States where tested. Because of this lack of hardiness, selections of superior wild forms should be tested only in western Washington and Oregon and in northwestern California. Cuttings, 6 to 8 inches long, with four to six of the upper leaves left on, taken during the winter, are readily rooted (fig. 6).

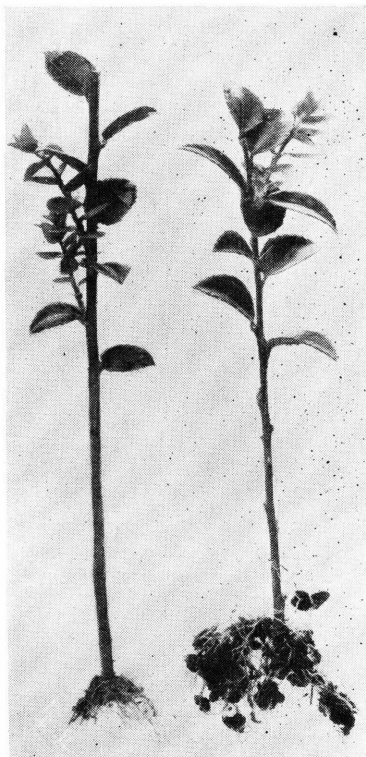


FIGURE 6.—Rooted cuttings of the evergreen blueberry, which is propagated relatively easily by means of cuttings having 4 to 6 leaves, taken during the winter.

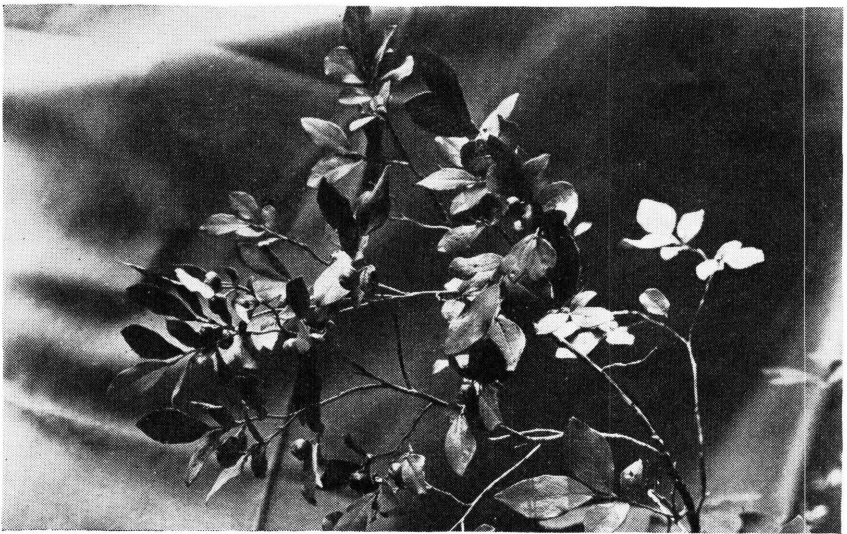
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MOUNTAIN BLUEBERRY

The mountain blueberry, also called "broadleaved huckleberry," is a native of the high slopes of the Cascade Mountains of Oregon and Washington and eastward to Wisconsin. It is most abundant near Crater Lake, Mount Hood, Mount Adams, and Mount Rainier, where thousands of visitors pick the fruit each year. It is a very drought-resistant plant, matures its fruit in the late summer even after 3 or 4 rainless months, and is important for forage. The plants grow 3 to 5 feet high and are abundant in burned-over areas. In the Cascade Mountains area at least, it is one of the best flavored and uniformly largest fruited of all wild blueberries. The annual value of the fruit crop may total \$200,000. The berries are somewhat pear-shaped, black or maroon in color, juicy, high-flavored, and rather tart but not too tart to be eaten fresh. Because its berries are borne singly (fig. 7) or in pairs rather than in clusters like those of the other blueberries, the individual bushes are not highly productive and are not likely to become important under cultivation. No cultivated plantings are known.

RABBITEYE BLUEBERRY

The rabbiteye blueberry is native to river valleys and the edge of woods in southern Georgia, southern Alabama, and northern Florida. It is harvested from the wild to a very limited extent. It is chiefly important because it grows on locations with more upland conditions than the highbush and because it requires a very short, cold rest period in winter. Also, it is not so sensitive to soil acidity and is far more heat- and drought-resistant than the highbush. More than 3,500 acres, located in northwestern Florida, North Carolina, South Carolina, Georgia, Alabama, Mississippi, and Louisiana, have been planted to this species, the plants having been transplanted from the



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FIGURE 7.—A branch of the mountain blueberry, the fruits of which are gathered extensively in the Cascade Mountains of Oregon and Washington.



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FIGURE 8.—Mature rabbiteye blueberry bushes at Crestview, Fla., showing the many shoots and great height of some varieties of this species.

wild into commercial fields. No figures on the market value of the crop of this blueberry are available. A considerable part of the crop is frozen or canned.

Because much fruit shipped from the South has come from the unselected bushes, many of which produce small, gritty-fleshed berries, lacking in flavor, the rabbiteye has had a poor reputation in markets. The berries are mostly black and not so attractive as the blue-fruited species and varieties. However, some named rabbiteye varieties bear large, juicy, aromatic, blue fruit that compares favorably with that borne by selections of other species. (Fig. 8.)

BLUEBERRIES FOR THE HOME GARDEN

Blueberries can be produced in home gardens if the soil is naturally acid or is properly treated. They do not succeed in ordinary rich garden soils and soon die, but they do thrive in naturally moist acid soils such as those in which native blueberries and huckleberries, azaleas, laurel, and rhododendrons grow. For small plantings mulchings with leaves, sawdust, hay, or straw to a depth of 5 or 6 inches helps to retain

moisture, to keep down weeds, to control erosion, and to keep the ground cool. Blueberries should not be planted on soils limed in recent years unless actual tests have shown that they are still acid enough for blueberries. For the less acid soils, decaying oak leaves or acid peat mixed in the soil around the plants helps to make conditions suitable, but plants on such soils will always require extra care.

At least two varieties should be planted to provide for cross-pollination.

In the Southern States from eastern North Carolina to Florida and west to Arkansas and Louisiana, varieties of the rabbiteye blueberry may be grown in home gardens. Two plants each of Homebell, Tif-blue, Coastal, and Callaway might be selected.

From North Carolina to southern Maine and west to Michigan wherever the soils are sufficiently acid and moist the highbush varieties may be grown in home gardens. In New Jersey, the New England States, and Michigan, Earliblue may be selected as a good early variety and Blue-ray as an early midseason variety. Bluecrop is suggested for midseason. The recommended later varieties are: Pemberton, Herbert, and Coville. For North Carolina gardens Wolcott is a good early variety; Scammell a midseason; and Jersey a late. Bird protection by means of 1-inch chicken wire or tobacco-cloth cages over the bushes is essential.

RABBITEYE VARIETIES AND THEIR CULTURE

The rabbiteye blueberries are suggested for local market and home use in the Coastal Plain from eastern North Carolina to northern Florida and to Louisiana and Arkansas. Limited test plantings for general market are suggested for the same area. In the Piedmont areas of the Southern States, rabbiteye varieties often complete their rest period early in the winter and then start growth so that buds are killed by late winter cold.

The rabbiteye blueberries (figs. 8 and 9) are generally set in mid-winter 10 by 10 to 15 by 15 feet, depending on variety. For home plantings they may be set as close as 8 by 8 feet. Under good conditions they grow rapidly and bear commercial crops by the third year. They respond to cultivation or mulching and fertilization. In one planting in southern Georgia, the average annual yield of the Black Giant for the first 11 years of bearing was 9 quarts per plant; the eleventh year the yield was 30 quarts per plant. Pruning is not generally practiced, but because the fruiting habit of rabbiteye is very like that of the highbush blueberry some pruning of older bushes is considered desirable. The older stems and the smaller young shoots may need thinning to prevent the bushes from becoming too dense; pruning should be relatively light, however, because the rabbiteye blueberry is sufficiently vigorous to support and bring to large size heavy crops of fruit. Heavy pruning results in excessive water-sprout growth.

Under the same growing conditions, the fruit of rabbiteye blueberry ripens later and over a longer season than that of the highbush and dryland blueberries. Picking in northern Florida usually begins near the end of May. Some varieties of rabbiteye blueberry ripen most of their fruit within a 30-day period, whereas other varieties not propagated now may mature fruit over a period of 3 months, the season extending into September in North Carolina. Selected varie-



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FIGURE 9.—A planting of rabbiteye blueberry at Crestview, Fla. Plantings of 50 to 100 acres are not uncommon.

ties have firmer fruit with a much smaller scar where the berry is picked from the stem than do highbush varieties.

Characteristics of some rabbiteye varieties are given in table 1. Walker and Ethel are 2 of the better selections from the wild that have been propagated. Callaway and Coastal are 2 new varieties introduced in 1950, and Homebell and Tifblue are 2 new ones introduced in 1955.

Callaway and Coastal, resulting from breeding work, and crosses of Myers \times Black Giant, both have larger fruit than have the older varieties; Callaway and Tifblue have the best flavor of rabbiteye blueberries. Homebell, also a cross of Myers \times Black Giant, has large fruit and a very vigorous productive bush. Tifblue, a cross of Ethel \times Clara, is largest and lightest blue of all of the rabbiteye varieties.

Other promising varieties have been selected and are being propagated for general planting. As far as they have been observed, the named varieties, except Locke, have been so resistant to stem canker (a

TABLE 1.—*Rabbiteye blueberry varieties ranked approximately in order of merit with reference to certain characteristics*

Rank	Season (early to midseason)	Size of berry (large to small)	Dessert quality (good to poor)	Color (light-blue to black)	Bush size (large to small)
1-----	Coastal-----	Tifblue-----	Tifblue-----	Tifblue-----	Homebell.
2-----	Callaway-----	Coastal-----	Callaway-----	Ethel-----	Coastal.
3-----	Tifblue-----	Homebell-----	Ethel-----	Callaway-----	Tifblue.
4-----	Walker-----	Callaway-----	Walker-----	Homebell-----	Callaway.
5-----	Ethel-----	Walker-----	Homebell-----	Walker-----	Walker.
6-----	Homebell-----	Ethel-----	Coastal-----	Coastal-----	Ethel.

serious southern disease) that no infections have ever been found on them. Future plantings should consist entirely of the more desirable named varieties. Two rows alternating with two other rows of a different named variety should be planted because cross-pollination is necessary.

Propagation has been chiefly by offshoots, or suckers, which arise at distances of a few inches to 8 feet from the parent plant. These are usually grown in the nursery for a year before being set in their permanent location. Recently large-scale propagation by summer cuttings under mist has been very successful and an even larger percentage of the softwood cuttings root than of many highbush blueberries (p. 27). Hardwood cuttings of rabbiteye varieties do not root easily.

The most serious insect pests of rabbiteye are fruitworms, stem borers, and mites. Stem canker, fruit spot, powdery mildew, phomopsis twig blight, and mummy berry are diseases of the rabbiteye.

HIGHBUSH VARIETIES AND THEIR CULTURE

SOIL CONDITIONS

The highbush blueberry is found in the wild only where the soil is very acid and moist. Usually the best wild growth occurs where the acidity ranges from pH 4.3 to 4.8, and cultivated plantings have succeeded on such acid soils. Good growth may occur in soils with a pH value as low as 4; however, where the acidity is as low as pH 4, application of ground magnesium limestone to bring the soil pH up to 4.5 in soils of medium texture should be tried. Where the acidity is as high as pH 5.5, finely ground sulfur² or ammonium sulfate may be used. If the soil is sandy or sandy containing some peat, ammonium sulfate should be used as it both acidifies the soil and furnishes nitrogen. If the soil is a loam, it may contain enough nitrogen and sulfur may be used to acidify it. Iron chelates are just coming into use to correct chlorosis of blueberry foliage.

The best indication that blueberries may succeed on a soil is that they or some related plants, such as huckleberries, azaleas, or laurel are found growing there naturally. Open porous soils, such as a sand-peat mixture with an admixture of loam, with the water table 14 to 30 inches below the surface, have been found best for blueberries.

CLIMATIC REQUIREMENTS

The cultivated highbush blueberry is raised commercially from eastern North Carolina northward to southern New England and also in western New York, in southern Michigan, and in western Oregon and Washington. The plant is probably not hardy north of southern Maine and central Michigan, as it does not stand temperatures lower than about -20° F. Instances have been reported of the tops being killed to the ground or to snow level at a temperature of -30° . However, even in sections where the blueberry is not generally hardy,

² As the result of studies in New York, it is recommended that to acidify sandy soils $\frac{3}{4}$ pound of sulfur per 100 square feet be applied for each full point that the soil registers above pH 4.5 and that to acidify medium loams $1\frac{1}{2}$ to $2\frac{1}{4}$ pounds be applied for each full point above pH 4.5.

local conditions of air drainage or protection by deep snow may make blueberry growing possible. The southern limit for present-day highbush varieties is about 300 miles north of the Gulf of Mexico from Georgia to Louisiana. In Florida, southern Georgia, and southern Louisiana the cold period is so short that the bushes do not break their winter rest period and blossom normally. They probably need about the same amount of cold in winter as does the Elberta peach. The highbush varieties are not so satisfactory as the rabbiteye varieties in South Carolina, Georgia, Alabama, Mississippi, and Louisiana. The early varieties begin to ripen during the latter part of May in Georgia and eastern North Carolina, the last of June in New Jersey, and mid-July in Massachusetts and Michigan.

The highbush blueberry is native to swamps and moist soils, and unless ample soil moisture is available the plants may die in periods of low humidity. The hot, drying winds of summer in the Central States may prevent the successful culture of this blueberry in that area. Moreover, most of the prairie soils are not acid enough for the blueberry.

VARIETIES AND THEIR CHARACTERISTICS

In 1906 the late F. V. Coville began experiments in the culture of the highbush blueberry. Selections were made in the wild, and breeding work was begun in 1909. Miss Elizabeth C. White, Whitesbog, N. J., made additional selections of wild plants and in cooperation with Coville established the first commercial plantings of hybrid blueberries. The breeding work has continued since 1909, and 29 selections have been named and propagated.

Formerly several selections from the wild (Rubel, Dunfee, Harding, Grover, and Adams) were grown commercially, but now only the Rubel of that group is considered of sufficient commercial value to be planted; most growers consider Atlantic, Herbert, Pemberton, Jersey, Berkeley, Coville, Burlington, and Dixi better varieties than Rubel and of about the same season. Breeding has produced berries about three times the size of the best wild blueberry. All varieties other than Rubel now being planted commercially are the result of the breeding work of Dr. Coville. All the commercial varieties are of pure highbush parentage except Rancocas and June, which are highbush backcrosses (Rubel \times a selection from a lowbush-highbush cross), Weymouth, which is a second backcross to the highbush (June \times Cabot), and the Angola, Croatan, Murphy, and Wolcott, which are third backcrosses to the highbush. Table 2 lists the varieties and gives an estimate of the relative acreage of each.

Berries of any one variety are picked about once each week for 3 to 5 weeks. Table 3 gives the approximate percentage of the crop picked each week for varieties if given a moderate pruning.

To keep a picking crew occupied from June 15 to August 9, a blueberry planting in Maryland might be planted to equal areas of 4 varieties that could be harvested successively (table 4).

Varieties differ in their relative ripening season from year to year and to some extent from section to section. Thus, following the warm winter of 1949-50 many varieties in North Carolina ripened much later than usual. The heavy pruning commonly practiced in North Carolina also causes the crop of any given variety to ripen earlier and in a shorter period than does the lighter pruning used in Michigan.

TABLE 2.—Percentage of estimated 1955 acreage planted to each of 29 varieties originated by F. V. Coville, listed in order of their dates of naming or introduction ¹

Name	Parentage	Year cross made	Year named or introduced	Estimated acreage (1955)	Characteristics responsible for introduction
Pioneer	Brooks × Sooy	1912	1920	<i>Percent</i> 1	Midseason, high flavor.
Cabot	Brooks × Chatsworth	1913	1920	1	Early.
Katharine	Brooks × Sooy	1913	1920	0	High-flavored; noncommercial.
Greenfield	Brooks × Russell	1913	1926	0	Earliest; noncommercial.
Rancocas	(Brooks × Russell) × Rubel	1915	1926	7	Productive; commercial.
Jersey	Rubel × Grover	1916	1928	40	Late; hardy; productive.
Concord	Brooks × Rubel	1916	1928	1	Productive.
Stanley	Katharine × Rubel	1921	1930	7	High-flavored.
June	(Brooks × Russell) × Rubel	1919	1930	0	Very early.
Scammell	(Brooks × Chatsworth) × Rubel	1915	1931	1	Productive; canker-resistant.
Redskin	Brooks × Russell (F ₂)	1913	1932	0	Red-colored; noncommercial.
Catawba	do.	1913	1932	0	Catawba-grape color; noncommercial.
Wareham	Rubel × Harding	1915	1936	0	Very late; high flavor.
Weymouth	June × Cabot	1928	1936	8	Very early; commercial.
Dixie	(Jersey × Pioneer) × Stanley	1930	1936	1	Large; high flavor.
Atlantic	Jersey × Pioneer	1925	1939	1	Large; late; commercial.
Burlington	Rubel × Pioneer	1916	1939	2	Very late; stores and ships well.
Pemberton	Katharine × Rubel	1921	1939	3	Very vigorous; large; late.
Berkeley	Stanley × (Jersey × Pioneer)	1932	1949	5	New; very large; light blue; commercial.
Coville	(Jersey × Pioneer) × Stanley	1930	1949	7	New; very large; latest; commercial.
Wolcott	Weymouth × (Stanley × Crabbe 4)	1934	1950	4	Very early, for North Carolina; commercial.
Murphy	do.	1934	1950	1	Early, for North Carolina.
Angola	do.	1934	1951	0	Very early; canker-resistant.
Ivanhoe	(Rancocas × Carter) × Stanley	1933	1951	0	High-flavored; vigorous.
Bluecrop	(Jersey × Pioneer) × (Stanley × June)	1934	1952	0	Hardy; light blue.
Earlibue	Stanley × Weymouth	1936	1952	0	Very early; hardy.
Herbert	Stanley × (Jersey × Weymouth)	1932	1952	0	Late; very large; high-flavored.
Croatian	Weymouth × (Stanley × Crabbe 4)	1934	1954	0	Early; canker-resistant.
Blueray	(Jersey × Pioneer) × (Stanley × June)	1934	1955	0	Large; productive; high flavor.

¹ About 10 percent of the estimated acreage was planted with Rubel, a variety selected from the wild by Miss E. C. White.

TABLE 3.—Percentage of the crop picked each week during the ripening season of 21 blueberry varieties

Variety	First week	Second week	Third week	Fourth week	Fifth week	Sixth week	Seventh week	Eighth week	Ninth week
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Angola.....	80	20	—	—	—	—	—	—	—
Croatan.....	60	30	10	—	—	—	—	—	—
Walcott.....	60	30	10	—	—	—	—	—	—
Earliblue.....	50	30	20	—	—	—	—	—	—
Weymouth.....	50	30	20	—	—	—	—	—	—
Murphy.....	—	50	30	20	—	—	—	—	—
Ivanhoe.....	—	30	40	30	—	—	—	—	—
Rancocas.....	—	30	30	20	10	10	—	—	—
Stanley.....	—	—	40	30	20	10	—	—	—
Bluecrop.....	—	—	20	40	30	10	—	—	—
Concord.....	—	—	—	50	30	20	—	—	—
Scammell.....	—	—	—	40	30	30	—	—	—
Berkeley.....	—	—	—	40	30	30	10	—	—
Atlantic.....	—	—	—	30	30	30	10	—	—
Pemberton.....	—	—	—	20	40	30	10	—	—
Rubel.....	—	—	—	20	40	30	10	—	—
Jersey.....	—	—	—	—	40	30	10	—	—
Dixi.....	—	—	—	—	50	40	10	—	—
Herbert.....	—	—	—	—	50	40	10	—	—
Burlington.....	—	—	—	—	20	40	30	10	—
Coville.....	—	—	—	—	—	30	30	30	10

TABLE 4.—*Usual harvesting period in Maryland for 4 varieties of blueberries, and percentage of crop that could be picked during each period*

Variety	Crop to be picked during—			
	June 15 to 28	June 29 to July 12	July 13 to 26	July 27 to Aug 9
	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
Earliblue.....	90	10	-----	-----
Stanley.....	20	60	20	-----
Berkeley.....	-----	30	60	10
Coville.....	-----	-----	30	60

Varieties for Different Seasons

Cultivated plantings include about 21 varieties. Information on the merits of some of these is limited, but the discussion in this section and the information summarized in tables 3 and 5 may give an idea of their relative qualities. Climate and weather conditions affect the dessert quality and other characteristics of the fruit as well as of the plants. In general the berries are more highly flavored toward the northern limit of the blueberry areas, where the days are long and the nights cool when the berries ripen. When days are sunny and nights cool in more southern regions the flavor is much better than when the days are hot and cloudy and the nights warm. The varieties mature their berries over periods of 2 to 6 weeks (fig. 10). They are grouped as early, early midseason, midseason, late midseason, and late varieties.

Early Varieties

The Earliblue and Weymouth are early varieties for the North, and Angola, Croatan, Wolcott, and Murphy are new early varieties for North Carolina planting. Weymouth berries lack dessert quality; are soft, dark, and drop. In North Carolina it is being replaced by newer varieties and in New Jersey and northward by Earliblue. Angola, Wolcott, and Murphy are highly resistant and Croatan is relatively resistant to stem canker, and should replace other early varieties in North Carolina. Tests so far indicate that they are not satisfactory in Maryland or New Jersey. Early varieties are early only if they are pruned rather heavily and large clusters pruned back (fig. 11).

Early Midseason Varieties

Blueray, Ivanhoe, Rancocas, and Stanley are early midseason varieties. Blueray and Ivanhoe are the largest and best flavored. Ivanhoe has the best scar but is not hardy north of Maryland while Blueray has been consistently hardy. Stanley is also high flavored, the bush very easy to prune but the berries become small at the end of its season and it should be replaced by Blueray. Rancocas is dependably productive but its berries crack badly in wet weather, are small and expensive to pick and it is being discarded by growers.



70321

FIGURE 10.—Two highbush blueberry flower clusters. To left, the ideal size of cluster made up of 5 individual small clusters. To right, a cluster made up of 11 small clusters and too large for best development of berries and growth of bush for the following year's crop. The flowers in any one cluster open over a period of several days and the berries mature over a still longer period.

TABLE 5.—*Highbush blueberry varieties ranked approximately in order of merit for certain growth, ripening, and other characteristics*

NORTH CAROLINA VARIETIES

Rank	Season (early to late)	Size of berry (large to small)	Dessert quality (good to poor)	Color (light to dark blue)	Shipping quality (good to poor)	Cold resistance (hardy to tender)
1	Angola	Angola	Croatan	Croatan	Wolcott	Scammell
2	Wolcott	Croatan	Angola	Wolcott	Scammell	Murphy
3	Croatan	Wolcott	Scammell	Murphy	Murphy	Wolcott
4	Murphy	Murphy	Wolcott	Scammell	Croatan	Croatan
5	Scammell	Scammell	Murphy	Angola	Angola	Angola

NORTHERN VARIETIES

1	Earliblue	Herbert	Herbert	Berkeley	Burlington	Bluecrop
2	Weymouth	Berkeley	Ivanhoe	Bluecrop	Berkeley	Earliblue
3	Ivanhoe	Coville	Dixi	Stanley	Bluecrop	Burlington
4	Rancocas	Bluecrop	Bluecrop	Atlantic	Ivanhoe	Bluecrop
5	Stanley	Bluecrop	Stanley	Atlantic	Jersey	Bluecrop
6	Bluecrop	Ivanhoe	Coville	Jersey	Earliblue	Jersey
7	Bluecrop	Bluecrop	Atlantic	Earliblue	Rancocas	Rubel
8	Concord	Atlantic	Pemberton	Ivanhoe	Atlantic	Herbert
9	Berkeley	Pemberton	Bluecrop	Coville	Rubel	Atlantic
10	Pemberton	Earliblue	Earliblue	Concord	Coville	Berkeley
11	Atlantic	Weymouth	Concord	Burlington	Herbert	Weymouth
12	Rubel	Jersey	Berkeley	Rubel	Bluecrop	Coville
13	Jersey	Concord	Burlington	Herbert	Stanley	Rancocas
14	Dixi	Stanley	Jersey	Rancocas	Dixi	Dixi
15	Herbert	Burlington	Rancocas	Dixi	Weymouth	Pemberton
16	Burlington	Rancocas	Rubel	Pemberton	Pemberton	Stanley
17	Coville	Rubel	Weymouth	Weymouth	Concord	Concord
						Ivanhoe



6508-2

FIGURE 11.—A 3-year-old bush with a good commercial crop of fruit and fine new growth. Ordinarily, unless large clusters such as these shown are pruned back, the berries are not very large and ripen over a long period, and insufficient new wood is produced for a full crop the following year.

Midseason Varieties

Bluecrop, Berkeley, Concord, Pioneer, and Scammell are considered midseason varieties. Bluecrop, although recently introduced, is very light blue in color and considered one of the hardiest and most dependable varieties. Berkeley is about 5 days later than Bluecrop, larger and the lightest blue of all. Both are firm and good shippers. Unless they develop some weakness they should replace Concord, Pioneer, and Scammell in New Jersey and northward. Scammell, being highly resistant to canker, is considered the best midseason variety for North Carolina.

Late Midseason Varieties

Atlantic and Pemberton are about 5 days later than Berkeley and 5 days earlier than Coville and Herbert. Pemberton is the most vigorous and most consistently productive under most conditions but cracks some in wet weather and tears more than most other varieties (figs. 12, *A* and 13, *B*). Atlantic is lighter blue, has a good scar and cracks less than most varieties.

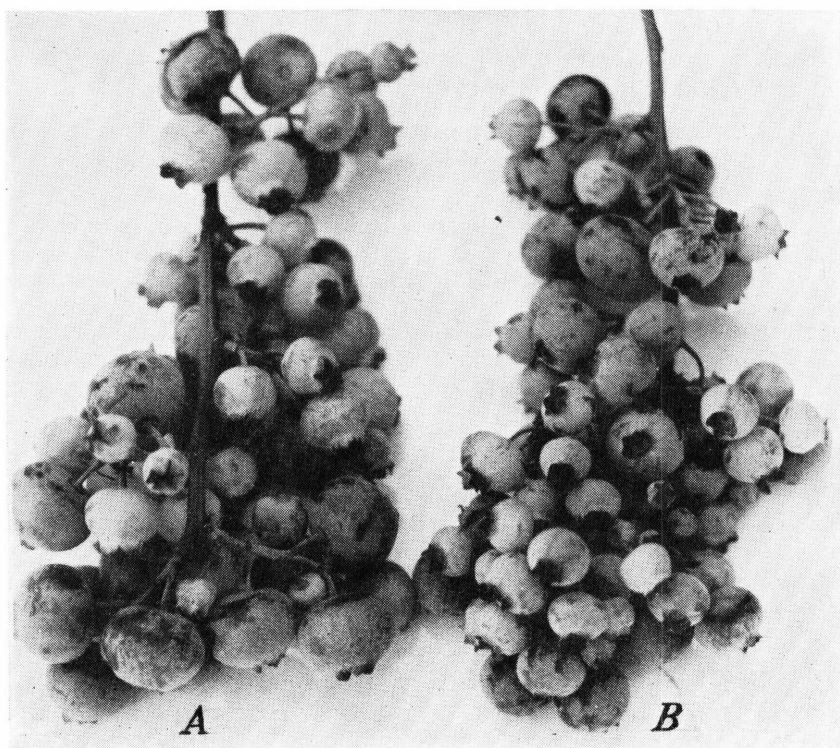
Late Varieties

Rubel, Jersey, Dixi, Herbert, Burlington, and Coville are late varieties. The season of any of these may be extended about 2 weeks by light pruning and leaving a heavy crop on the bushes. Herbert, Coville, and Dixi bear the largest berries. Herbert has the finest flavor but is slightly soft. Dixi has high flavor but has a bad scar and the berries crack badly. Burlington is considered a much better

storage and shipping variety than most varieties. Its berries have fine scars, a good blue color, fairly good flavor and do not crack but they are of only average size. Its bush is very hardy, vigorous, and easy to prune. Jersey has very open clusters and a vigorous bush that is easy to prune. It is still the leading variety in New Jersey and Michigan. Herbert and Coville are among the most promising commercial varieties.

Varieties for Different Sections

For western North Carolina, Maryland, and New Jersey: Earliblue for early season; Blueray for early midseason; Bluecrop and Berkeley for midseason; Atlantic and Pemberton for late midseason; and Jersey, Herbert, and Coville for late season are desirable. In eastern North Carolina: Angola, Wolcott, Croatan, and Murphy for early season and Scammell for midseason are suggested. Jersey is raised there for the late season although later varieties are considered less desirable than early ones. In Michigan and New England, Jersey is the standard sort. However, Earliblue, Blueray, and Berkeley are good for early, early midseason, and midseason, respectively. For late season Herbert and Coville are suggested. In western Oregon and Washington, Stanley and Dixi are known to succeed but Earliblue, Blueray, Bluecrop, Berkeley, Herbert, and Coville should be tried.



63877

FIGURE 12.—Clusters of blueberries: A, Pemberton; B, Rubel. These two varieties ripen at about the same season.

Varietal Descriptions

Angola.—Bush vigorous, open spreading, productive; leaf large; fruit cluster loose; berry medium size, globose, somewhat soft, good aroma, good flavor, dark blue like Weymouth, fair dessert quality; scar medium; earliest of all. Grown only in North Carolina. Too dark for best market appearance.

Atlantic.—Bush vigorous, open spreading, productive; leaf large; fruit cluster loose, berry large, five-sided, oblate, of good blue color, firm with slight aroma, medium in dessert quality; scar above medium, resistant to cracking; season late, ripening slightly earlier than Jersey. Subject to bacterial dieback in Oregon and Washington. Liked in New England for large size, fine color, good fruit scar and productiveness.

Berkeley.—Bush vigorous, open spreading, productive; leaf large; fruit cluster loose; berry very large, oblate, lightest blue, firm with slight aroma; medium in dessert quality; scar excellent and stores well; resistant to cracking; season late midseason. Well liked for its beauty of color, large size, firmness and productiveness.

Bluecrop.—Bush average vigor; upright spreading; productive; hardier and more drought resistant than most; fruit cluster loose; berry large, oblate, lightest blue except for Berkeley; firm, resistant to cracking, slight aroma, above medium in dessert quality; scar one of best; midseason, 4 days before Berkeley.

Blueray.—Bush very vigorous, hardy, upright, spreading, productive; fruit clusters small, tight; berry very large, light blue, firm, resistant to cracking, aromatic and similar to Dixi, highly flavored; scar medium; early midseason, about with Rancocas if pruned rather heavily. Promising new variety from New Jersey northward.

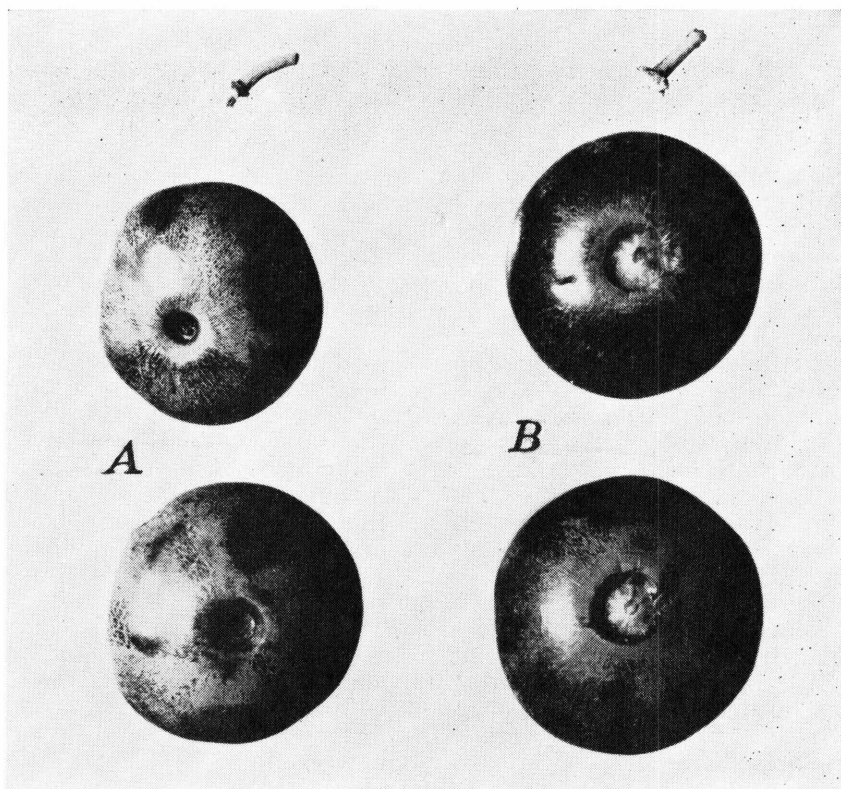
Burlington.—Bush vigorous, upright spreading; leaf large; fruit cluster medium tight; berry medium size, round-oblate, of good blue color, firm, with slight aroma, medium in dessert quality; scar one of best; resistant to cracking; season late, lasting about a week after Jersey and Rubel. Promising for its lateness, its fine scar (fig. 13, A), superior to that of most other highbush varieties for its hardiness and its good cold storage qualities.

Concord.—Though productive and large, not promising because of having bad scar and being expensive to prune.

Coville.—Bush vigorous, open spreading, productive; leaf large; fruit cluster loose; berry very large, round-oblate, of good blue color, firm, aromatic, of good dessert quality but tart till ripe; scar good; resistant to cracking; season latest of all, 10 to 14 days after Jersey; does not drop. Liked for its very late season, large size, nondropping and productiveness.

Croatian.—Bush vigorous, spreading, productive; leaf large; fruit cluster loose; berry medium to large, globose, about color of Weymouth, medium firm, slightly aromatic, good dessert quality, scar one of best, season with Weymouth and Wolcott. Promising in eastern North Carolina.

Dixi.—Bush vigorous, open spreading, productive; leaf large; fruit cluster medium tight; berry very large, round-oblate, of fair blue color, firm, aromatic, high dessert quality; scar large; subject to cracking; season late, slightly after Jersey. Liked for its large size, high dessert quality and productiveness but has a poor scar and cracks badly in wet weather. Liked in western Oregon and Washington and in Ohio.



68032

FIGURE 13.—A, Berries of Burlington, showing small clean scars where the berries separated from the stems; B, berries of Pemberton, showing tearing of the skin and flesh and large scars.

Earliblue.—Bush vigorous, upright, productive; fruit cluster loose; berry large, light blue, firm, resistant to cracking, aromatic, good dessert quality; scar good; season early, with Weymouth. Proving best early variety for Maryland northward. Larger, firmer, bluer, better flavored, more vigorous and more productive than Weymouth.

Herbert.—Bush vigorous, upright spreading, productive; fruit clusters loose; berry very large, medium blue; medium firm, resistant to cracking, aromatic, one of best in dessert quality; scar fair; season late about with Jersey. Consistently productive.

Ivanhoe.—Bush erect and very vigorous; cluster medium loose; productive where hardy, not dependably hardy north of Maryland and Delaware; berry large, round-oblate, light blue, firm, high aroma, one of best in dessert quality; scar one of best, liked in Maryland and Delaware.

Jersey.—Bush vigorous, erect, productive; leaf large; fruit cluster long and very loose; berry large, round-oblate, of good blue color, firm, lacking aroma, of below to about medium in dessert quality; scar good; season late, with Rubel. Liked for its vigorous fine, hardy bush, resistance to stem canker in North Carolina, open fruit cluster and late-ripening berry. Still most widely grown of any variety.

June.—Being replaced by Earliblue which is earlier and larger and a more vigorous grower.

Murphy.—Bush vigorous, spreading, productive; leaf large; fruit cluster loose; berry large, round-oblate, dark blue, similar to Weymouth in color, firm, slightly aromatic, of fair dessert quality; scar fair; season early, about with June. Promising in North Carolina for its early season and canker resistance; not promising in Maryland and New Jersey.

Pemberton.—Bush one of the most vigorous, erect, productive; leaf large; fruit cluster very loose; berry large, round to round-oblate, darker than Jersey and Atlantic, firm, with slight aroma, medium to above in dessert quality; scar poor (fig. 13, *B*); season late, slightly before Jersey and Rubel. Liked because of its productive vigorous bush and large size of berry; however, it is dark, difficult to pick and cracks somewhat in wet weather. Best adapted to home gardens.

Rancocas.—Bush of medium vigor, erect, productive; leaf small, serrate; fruit cluster very tight; berry small, oblate, of fair blue color, firm, crisp, with very slight aroma, medium in dessert quality; second early just after Wolcott, Murphy, Weymouth, and Earliblue. Leaf subject to June spot and drop in summer in Michigan, and berry cracks badly after rain.

Rubel.—Selection from wild. Bush erect, vigorous, productive; leaf medium size; fruit cluster very loose; berry medium size, oblate, of good blue color, firm, with slight aroma, of fair dessert quality; scar good; season late, with Jersey. Liked as a late variety for its hardiness and productiveness and in North Carolina for its resistance to stem canker, but in most new plantings, Herbert, Coville, Atlantic, Jersey, and Pemberton are substituted as larger fruited late varieties.

Scammell.—Bush erect, vigorous, productive; leaf very small; fruit cluster long and tight; berry large, if properly pruned; resistant to canker and grown in eastern North Carolina for midseason.

Stanley.—Bush erect, vigorous, but with few main branches; leaf very large; fruit cluster medium, loose; berry medium size, but last berries to ripen often very small, oblate, of good blue color, firm, very aromatic, of high dessert quality; scar above medium size; second early, ripening just after Rancocas. Though very aromatic the berries usually are not very large and do not keep well; liked where berries are of good size.

Weymouth.—Bush erect, open spreading, below average in vigor; leaf average size; fruit cluster medium loose; berry of above medium size, round-oblate, dark blue, lacking aroma, usually of poor dessert quality; scar medium; berries drop; very early, ripening all berries quickly. Planted extensively for early season, but dark, not of good quality, and subject to stem canker, stunt, and mite injury; Earliblue far better in North and Wolcott in the South.

Wolcott.—Bush very vigorous, upright, productive; leaf large; fruit cluster loose; berry large, round, dark blue, similar to Weymouth in color, firmer than Weymouth, aromatic, medium in dessert quality; scar small, very good; season early and short, with Weymouth. Promising in North Carolina for its early season, vigor, productiveness, good scar, and canker resistance; not promising in Maryland and New Jersey.

NEED FOR CROSS-POLLINATION

Results of experiments indicate that it is essential at least under some conditions to grow two varieties of blueberries near each other

for cross-pollination. The early experiments of Coville led him to state: "When blueberry flowers are pollinated with pollen from their own bush the berries are fewer, smaller, and later in maturing than when pollen comes from another bush [from a bush of another variety]." Experiments in North Carolina, New Jersey, and Massachusetts have, in general, confirmed Coville's results. However, growers have set solid blocks to a single variety, and the heavy crops of Rubel and Jersey grown in solid blocks indicate that so far the practice has been satisfactory. It is suggested that growers set two rows of one variety and alternate with two rows of another. All varieties seem to overlap enough in time of flowering to be effective pollinizers for any other variety.

GROWING AND CARE OF SEEDLINGS AND NATIVE PLANTS

Because the cultivation of the blueberry is a relatively new industry and most cultivated varieties are the result of breeding and have been introduced recently, many practices are being tested that would not be followed in an older industry. Several large fields of seedlings are still bearing fruit in New Jersey, Michigan, and Washington. Though they may produce good crops, the berries are variable in season, size, color, and flavor and are less desirable for the general market than are berries of cultivated varieties.

Some fields of bushes selected from the wild are also still being picked, but the fruit is much smaller and even less desirable than that of seedlings of varieties. Many areas of native bushes are being given some attention; the competing trees and bushes are being removed, the blueberries fertilized, and the bushes pruned. Where the stand of blueberries has been good this care has sometimes been profitable. Such berries, however, have to compete with the much larger fruit from cultivated plantings of selected varieties.

PROPAGATION

With careful attention the blueberry can be propagated extensively by either hardwood or softwood cuttings. The hardwood cuttings, 4 to 5 inches long, are made from dormant shoots of the previous season's growth, the lower cut being made just below a bud and the upper just above (fig. 14, A). Wood with fruit buds should be cut off and discarded, as but few cuttings with fruit buds root or make good plants. The cuttings are rooted either in ground beds with lath shade about 7½ feet above the ground (fig. 15) or in covered frames. Ground beds are those made directly on the ground; they are usually filled with a mixture of half peat and half sand to a depth of about 6 inches. The most commonly used covered frames are 6 feet by 27 inches by 16 to 40 inches deep and contain trays 4 inches deep with the bottom made of ⅜-to ¼-inch-mesh hardware cloth or fly screen. The trays rest on cleats 8 to 10 inches below the top of the frame. The trays are filled with peat or peat and sand, and the cuttings are placed about 1 inch apart in rows 2 inches apart and in a slanting position. An advantage of the tray is that it can be removed to a coldframe or to the nursery row, while cuttings in the ground bed require transplanting. In Michigan each frame is covered with a sash and then with coarse burlap, while in New Jersey either slat or lath covers are used for shade. Recently, experiments have shown that with bottom heat at 70° F. more and better rooting of hardwood cuttings is obtained.



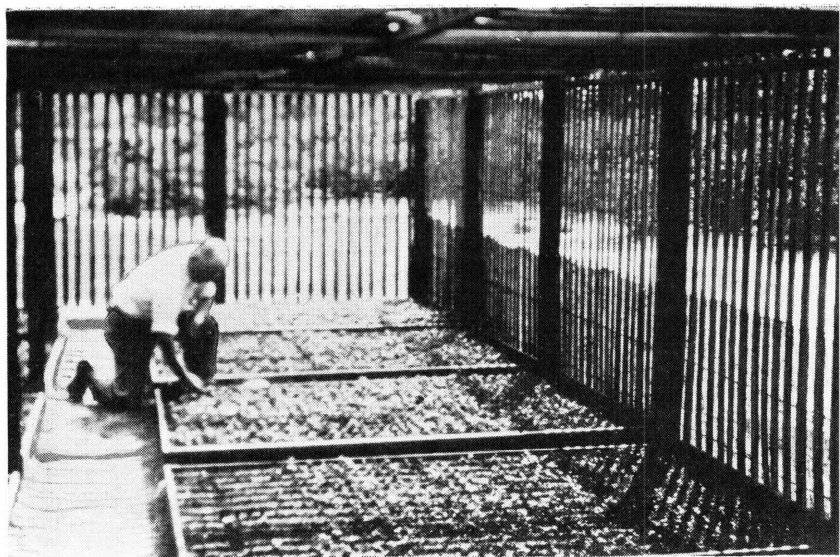
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FIGURE 14—*A*, Hardwood cuttings with fruit buds at tip; these should be cut off as indicated. *B*, Cutting with a shoot at the upper end and a good callus but no roots at the base. Roots should appear within a few days. *C*, Well-rooted cutting.

Cuttings are made while the plants are dormant. They may be stored in a cool moist place until they can be placed in the propagating beds early in the spring. Usually they have rooted by June (fig. 14, *B*, *C*), but are left in the ground beds or, if propagated in covered frames, are placed in coldframes until the following spring.

Softwood cuttings are made when secondary growth first appears on the new shoots. They are made about 4 inches long, and only the two upper leaves are left on the cutting. The upper half of each of the two leaves is usually cut off to reduce transpiration. In Michigan softwood cuttings are handled in frames as are the hardwood cuttings; in New Jersey they are propagated under glass. Softwood cuttings are little used commercially, except for the rabbiteye varieties which are difficult to root by hardwood cuttings.

Both hardwood and softwood cuttings are usually grown for a year in the nursery row before being planted in the fields. The nursery rows are usually 18 inches apart and the plants 6 to 10 inches apart in the row. After a year in the nursery row they are called 2-year plants. Well-grown 2-year plants are considered most desirable for field planting.



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FIGURE 15.—Propagation of blueberry by hardwood cuttings in ground beds made up of half peat and half sand, in a shade house with lath sides and top to give about one-half shade.

Angola, Croatan, Murphy, Wolcott, Earliblue, Blueray, Herbert, Rancocas, Rubel, Pemberton, Berkeley, and Coville are relatively easy to root from cuttings; Jersey, Concord, and Scammell are somewhat less so; and June, Ivanhoe, Atlantic, Bluecrop, and Stanley are more difficult.

PLANTING AND CULTIVATION

The plants are usually set 4 or 5 by 8 feet, 4 or 5 by 10, or 6 by 8 as early in the spring as the soil becomes suitable for working. Setting them 5 by 8 feet (1,089 plants per acre) or 6 by 8 (908 plants per acre) is suggested for new plantings. Setting 4 by 10 feet (1,089 plants per acre) or 5 by 10 (871 plants per acre) is suggested for plantings for standard tractor cultivation. In New Jersey some fall planting is done; in eastern North Carolina planting is done in the late fall or winter. The blueberry is shallow-rooted; therefore, cultivation should be shallow. Clean cultivation has been the usual practice, but because of danger of erosion and of soil impoverishment it is not advisable as a permanent practice. In Michigan a spring oat cover crop sown just after the harvest is recommended. Ground covers of lespedeza and annual bluegrass and mulches are being tested in New Jersey.

MAINTAINING SOIL FERTILITY

The essential requirements for successful blueberry culture are that the plants be vigorous and that they produce good crops each year. On fertile soils very little fertilizer may be required, while on poor soils larger amounts may be necessary to maintain satisfactory growth. In Michigan the application of superphosphate alone up to 670 pounds per acre has given good results, but about 500 pounds of a complete fertilizer has generally been somewhat better. In localities where

blueberries are now planted in New Jersey and North Carolina, nitrogen has seemed most often the limiting element. For locations where satisfactory practices are still unknown, it is suggested that one application, 400 to 600 pounds per acre, of a complete fertilizer (about 8-8-8 not neutralized) be made in the spring at the time the buds are starting. This should be followed about 6 weeks later, if the soil is not very acid (pH 4.8 or above), by an application of 100 pounds of ammonium sulfate per acre; and followed by one or possibly two similar applications at intervals of 6 weeks. The more fertile fields in the Northern States should not have the later fertilizer applications. The fertilizer should be broadcast to within 6 to 12 inches of the plant and out as far as the roots extend.

GOOD DRAINAGE ESSENTIAL

Although the highbush and rabbiteye blueberries are both natives of swamp and moist lands, cultivated fields should be well drained. The blueberry is considered a shallow-rooted plant because it survives in swamps and is not often found on high, dry sites. Vigorous productive bushes, however, can grow only where there is an extensive soil volume not saturated with water during the growing season and only for short times during the dormant season. Under such favorable conditions an extensive root system develops that can support a large bush and crop. If, because of heavy rains or poor drainage, the water table is raised for several days, the root system may be weakened or the plants killed; sometimes the lower part of the root system is killed so that when a drought follows such injury the whole plant may die. Precautions to obtain proper drainage should be taken, because the low-lying soils usually selected for blueberries often have depressions or pockets from which the water does not drain out and the blueberry plants are drowned.

IRRIGATION OFTEN PROFITABLE

Most areas where blueberries are grown are subject to droughts severe enough to injure both the plants and the crops. More and more blueberry growers are providing for irrigation. Many blueberry growers use an overhead sprinkler system, which can be used for frost protection also. Under ideal conditions of drainage and irrigation, excess water can be quickly removed during or after storms. In times of drought, 1 to 2 acre-inches of water should be applied about 10 days apart during the picking season and as needed later in the season during the heat of summer.

Mulching with sawdust or other materials helps to conserve moisture.

MULCHING

Mulching with sawdust, leaves, hay, or straw, as suggested for home garden plots of blueberries (p. 11), has been followed commercially on small areas in New England, New Jersey, Ohio, North Carolina, and northern Georgia with success. Mulching materials applied to a depth of several inches keep down weeds, keep the soil cooler in summer, help to retain soil moisture, and help to control erosion. Sawdust contains some substance which stimulates growth. The plant rows may be covered for 2 to 2½ feet on each side, or the entire area may be mulched. Leguminous hay mulches (clover, soybean, etc.) have

sometimes been injurious and should not be used unless thorough trial has shown no injury over a period of a year or more. When sawdust, leaves, hay, or straw are used, additional nitrogen must be applied to obtain good growth. Instead of using the 100 pounds of ammonium sulfate per acre required where mulches are not applied, two applications, each of 300 pounds per acre, should be used on mulched areas, 6 weeks apart. For small plantings $\frac{1}{4}$ to $\frac{1}{2}$ pound of fertilizer per bush should be scattered over the surface at each application, not closer than 6 to 8 inches to the base of the plant.

PRUNING

The blueberry produces fruit on wood of the previous season's growth. The largest fruit is borne on the most vigorous wood. Most varieties tend to overbear, and unless part of the buds of such varieties are pruned off the berries are relatively small and there is too little vigorous new growth for the next year's crop. The erect-growing varieties, such as Earliblue, Pemberton, Jersey, and Ivanhoe need to be thinned at the center, whereas Murphy is especially spreading and likely to need pruning of the lower drooping branches.

Heavy pruning (thinning the small branches, heading back or topping clusters, and cutting out some old stems) reduces the crop greatly and hastens ripening. It should rarely be practiced. Light pruning (thinning out some of the small branches and an occasional stem), though it reduces the crop for a particular year, increases the size and earliness of the berries and tends to produce more vigorous new growth for the next year's crop than does no pruning. The heavier the pruning the larger the berry size, the earlier the ripening, and the smaller the total crop for that year. Under some conditions where the crop is heavy and no pruning is done, few of the berries mature.

Tests in Michigan of different methods of pruning (table 6) illustrate the effect of pruning for 2 years, on yield per plant and size of berries. With Rubel, very heavy pruning as compared with light pruning reduced the crop more than 75 percent the first year and more than 50 percent the second year. On the other hand, it increased the size of the berries by about 25 percent the first year and by about 30 percent the second year. Similar decreases in yield and increases in size following very heavy pruning occurred with the Pioneer variety.

Pruning also had an important effect on the time of ripening. In the first season, 93 percent of the crop from heavily pruned Rubel bushes was harvested at the first picking; whereas with light and medium pruning only 63 and 65 percent of the crop, respectively, was harvested at that picking. With the Pioneer, 92 percent of the crop on heavily pruned bushes was harvested at the first 3 pickings (within 2 weeks), but on lightly pruned bushes only 54 percent ripened in the same period and the other 46 percent ripened over a 4- to 5-week period. Thus, it is possible to shift the ripening period by the amount of pruning done. In North Carolina and other Southern States relatively heavy pruning even at a sacrifice of yield may be practiced to obtain an early-maturing crop, and in the Northern States the practice of light pruning may spread the ripening season over several weeks.

Relatively less pruning is necessary on very vigorous plants. If plants are heavily fertilized and the soil-moisture supply is adequate

TABLE 6.—*Yield per plant and size of berries from full-grown bushes of the Rubel and Pioneer blueberries under different types of pruning at South Haven, Mich., for 2 successive seasons*

[1 pound = 1.14 pints]

Type of pruning	Berries per plant				Berries per half-pint cup			
	Rubel		Pioneer ¹		Rubel		Pioneer ¹	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
None-----	23. 4	20. 1	25. 3	26. 9	222	181	190	132
Light-----	17. 3	19. 9	18. 4	18. 8	189	204	173	136
Medium-----	16. 3	14. 3	17. 4	11. 0	174	192	151	130
Heavy-----	7. 6	8. 1	-----	-----	164	169	-----	-----
Very heavy--	3. 9	9. 1	5. 8	10. 8	145	145	85	99

¹ Being discarded.

at all times, they make much stronger growth and can produce a much heavier crop of large berries than if fertility is lacking and the soil-moisture supply is insufficient at times.

Usually very little pruning is necessary until the end of the third season, when regular annual pruning should ordinarily begin. The general practice is as follows: (1) The low spreading branches next to the ground should be cut out, leaving only the more erect branches or shoots; (2) if the center of the bush is dense, the weak and the older branches at the center should be cut out; (3) most of the small slender branches should be removed, leaving the strong branches and shoots (fig. 16). Often, many of these small branches are thickly set with fruit buds, and sometimes few of the slender branches have fruit buds. These weaker branches cause the bush to become too dense, thus making picking difficult and leaving inadequate space for strong new shoots. Rubel, Concord, and Rancocas bushes require much thinning out of the small branches and are, therefore, expensive to prune. Finally, in order to increase the size of the berries the fruiting shoots of some varieties should be cut back, the amount depending on the number of fruit buds on such shoots. Earliblue, Ivanhoe, Bluecrop, Bluejay, Berkeley, Herbert, and Coville require very little cutting back; Scammell requires cutting back to about three to five fruit buds per shoot. The amount of cutting back necessary varies from year to year, depending on growing conditions. Cutting back is usually done after danger of cold injury is past. General pruning may be done at any time from leaf fall in the autumn to the beginning of growth in the spring.

HARVESTING AND MARKETING

The first berries from the early varieties are picked about May 15 in North Carolina, June 15 in New Jersey, and July 10 in southern Michigan. From 3 to 7 pickings are made at 5- to 7-day intervals.



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FIGURE 16.—Four-year-old blueberry bush of the June variety: *A*, Before pruning; *B*, after pruning. Pruning reduced the fruit buds by about 75 percent. In very fertile soils a large number of fruit buds might be left for a heavier crop.

In any one locality the season usually lasts 6 to 7 weeks. To provide the best possible supply to markets, the North Carolina growers are mainly interested in early to midseason varieties, the New Jersey growers in midseason and late ones, and the Michigan growers in late sorts. In 8 hours a picker can harvest 60 to 80 pints, or even more where the crop is heavy. Pint baskets are used mostly as containers, but these have to be made tighter than for larger fruits such as strawberries. Most of the crop in the 3 States mentioned is marketed cooperatively. The berries are sold according to size grades, the larger berries usually bringing a higher price than the smaller ones. Early and late in the season small berries sometimes bring higher returns than larger berries in midseason.

YIELDS

Yields vary greatly. In Michigan on good soil the yields from the second to the sixth year usually increase from 50 to 6,000 pints per acre. Larger yields are possible; as many as 9,600 pints per acre have been obtained from good fields. Full production is reached in 6 to 10 years, but it may be reached earlier with good culture. Individual bushes should produce a little fruit after being planted 1 year. When mature, they usually bear 6 to 8 pints per plant, and with medium pruning they may even produce 12 to 20 pints per plant (table 6).

USES

Although most of the crop from cultivated fields is marketed in the fresh state, large quantities of the highbush blueberry are canned or frozen. Because the canned berries are used largely for pies they are packed mostly in water and to a lesser extent in a sugar sirup. The

frozen berries also are used mostly for pies and should be frozen with added sirup. Recently quantities have also been frozen in small containers for table use. Atlantic and Coville are two of the best for freezing. The frozen product is nearly equal to fresh fruit in appearance and quality. The frozen pack in 50-percent sirup is considered preferable to that in either 40- or 60-percent sirup and is much superior to packs that contain neither sirup nor sugar. Frozen berries are also superior to canned ones. Blueberry juice has been produced commercially to a limited extent.

BLUEBERRY DISEASES

Diseases cause more or less damage in all blueberry-growing sections.

In the South the loss from diseases is more serious than elsewhere. There stunt, a virus disease, is considered of first importance, as it affects most varieties and all bushes infected soon become unproductive. Stem canker is a close second in importance. Although most varieties are susceptible to stem canker, bushes remain productive for a few years after infection. Foliage diseases cause more damage than elsewhere.

In New Jersey, stunt is the most important disease, followed by mummy berry and powdery mildew. Stem canker is a minor problem. Foliage diseases other than mildew usually do not cause any damage.

In New England, mummy berry is severe in some years, powdery mildew is usually present, and witches'-broom and leaf rust do some damage annually.

The most important disease in Michigan is mummy berry, which causes considerable loss some years, especially in fields on muck soil. Stunt is increasing in a few fields. Foliage diseases, except mildew, are lacking.

In the Pacific Northwest, a tip and blossom blight, caused by *Botrytis* sp., does considerable damage. This disease is favored by the cool and foggy weather that prevails during the early growing season in this area.

BLUEBERRY INSECTS

The number of insects attacking blueberries is extensive. Several to many species of insects are native to areas where blueberries are cultivated and the insects spread to the cultivated fields.

In the North the blueberry maggot or blueberry fruitfly is generally present. In addition the cranberry fruitworm, the cherry fruitworm, and the plum curculio are often present. The leafhopper that spreads the blueberry stunt disease and the cranberry weevil that feeds on the flower buds are also important insects to be controlled. Fruit caterpillars, webworms, and the datana worm feed on the leaves; the bud mite, especially in North Carolina, often injures or destroys the flower buds; scale insects weaken the plants; stem borers and rootworms may weaken and destroy plants. The blueberry grower needs to become familiar with all these insects.

